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Sequential or non-sequential recruitment?

Abstract. This paper examines the recruitment process of firms. We test whether firms search sequentially or non-sequentially using data compiled from filled vacancies. According to theory, in case of sequential hiring, the number of applicants is proportional to the number of employees hired, whereas in case of non-sequential hiring, the number of applicants increases by less. We distinguish between different types of recruitment methods. We find that the sequential hiring is rejected for a number of methods (including advertisements) covering almost half of the vacancies, and the large majority of the job applications by job seekers. Informal recruitment methods tend to imply sequential search.

Keywords: sequential search, recruitment; JEL code J63

1. Introduction

In the theoretical job search literature, it is common to assume that firms search sequentially for employees although some studies allow for non-sequential search (Burdett and Cunningham, 1998). Given sequential search, firms offer a job to suitable applicants upon arrival and discontinue the search process if the job offer is accepted, whereas given non-sequential search, firms pool applicants and screen them all and the job is offered to the best applicant in the pool (if suitable). Van Ours and Ridder (1992, 1993), by decomposing the vacancy duration into an applicant arrival period and a selection period, conclude that firms search non-sequential and that vacancy durations are mainly selection periods.

It has been known for a long time that, depending on the circumstances, each of the recruitment strategies may be optimal (e.g. Morgan, 1983; McKenna, 1985). For example, in case that screening applicants is expensive, the arrival rate is low, and there are no economies of scale in screening, sequential search is more appropriate. On the other hand, if most job applicants apply within a certain short period, applicants can be cheaply examined (e.g., via pre-screening) and the costs of posting a vacancy are sunk (such as is the case with an advertisement), then non-sequential hiring may be preferred. Because the aforementioned considerations are likely to impinge on the choice of the recruitment method, the search strategy adopted is likely to be contingent on the recruitment method used, which in turn affects the arrival rate of applicants.

This paper tests whether firms search sequentially or non-sequentially, using a unique Dutch data set concerning filled vacancies. Our analysis is novel in three respects: first, by

using the proportionality between the number of filled vacancies and the number of applicants that arise when firms search sequentially, we are able to test explicitly for sequential search across recruitment methods; second the analysis is based on a large and rich set of data; third, the data covers eight years therefore cyclical effects in the labour market can be controlled for.

Our results indicate that firms do not search sequentially when they make use of job advertisements, the public employment service, or head-hunters (professional recruitment agencies). These three methods cover 45% of the filled vacancies, and 78% of job applications by job seekers. The use of informal recruitment methods (internal, via own personnel, business relations, open applications) tends to imply sequential search. The structure of the paper is the following: the next section offers the theoretical model. Section three presents the data description and the results from the empirical analysis. Section four finally concludes.

2. Theory

Consider a firm with several identical job openings. A priori (before screening), applicants are identical. Applicants are either suitable or non-suitable for the vacant job. The probability of hiring an applicant is constant and exogenously given (a stationary environment). The average number of applicants to be screened before finding a suitable applicant is denoted as α. The screening of applicants is costly and the screening costs for each applicant are fixed.

Now presume that it is optimal for a firm to screen applicants sequentially. In this case, the firm will screen each period *one* applicant until the number of suitable applicants, n, is equal to the number of job openings. A firm that tries to fill v vacancies in sequential order is therefore behaving as if it recruits to fill one vacancy v times (v recruitment actions). Hence, the expected number of applicants, $E(n)$, is proportional to the number of job openings v, so that $E(n) = \alpha v$ or $n = \alpha v \varepsilon$, where $\alpha > 0$ and ε is random error with $E(v) = 1$, implying that:

$$\log n = \alpha + \log v + \log \varepsilon . \qquad (1)$$

Now presume that it is optimal for firms to screen non-sequentially, so each period *more than one* applicant is screened and the number of applicants is optimally chosen (e.g., Morgan, 1983). The number of applicants is determined by the usual condition that the marginal costs

of screening are equal to the marginal benefits of filling the job opening with a suitable applicant. The optimal number of applicants increases in the number of job openings, because the marginal benefits are an increasing function of the number of job openings, whereas the marginal costs of screening are given (and thus do not depend on the number of applicants). The positive relationship between the marginal benefits from search and the number of job openings arises because within a pool of applicants there may be more than one suitable applicant, therefore more than one vacancy could be filled at the same time from the pool of applicants. Further, the marginal benefits of screening are a decreasing function of the number of applicants. The latter is the case, because the probability of filling a job opening with a suitable applicant is a concave function of the number of applicants. Hence, the expected number of applicants is less than proportional to the number of job openings, so $E(n) = \beta v^{\gamma}$, where $\beta > 0$ and $\gamma < 1$, implying that:

$$\log n = \beta + \gamma \log v + \log \varepsilon, \text{ where } \gamma < 1. \tag{2}$$

To summarise, if γ is smaller than one, firms recruit non-sequentially, which can be tested against the alternative hypothesis that γ be equal to one when firms recruit sequentially.[1]

3. Data and Results

3.1 The data and descriptive analysis

The data used in the empirical analysis are derived from a survey on recruitment behaviour of Dutch firms "How do firms recruit?" between 1991 and 1998. The survey is carried out by telephone every two months. The data do not have a panel structure, because a new random sample of firms is drawn each time. To begin with, firms are asked to report on their total hiring activity during the past year (the number of filled vacancies).[2] Then, the interview focuses on a more recent hiring activity, which has been carried out during the two months prior to the interview. Firms may have carried out more than one hiring activity in this period.

[1] Suppose a non-stationary environment where the probability to fill a vacancy declines in the number of vacancies already filled, because the quality of the applicants deteriorates over time. Firms would then reject, on average, more and more applicants as the number of already filled vacancies increases. We would then observe that $\gamma < 1$ in case of sequential search. This seems to indicate that our test may be biased towards rejecting the null hypothesis of sequential search. Note however that, a priori, there are no strong arguments to support the hypothesis of a deteriorating quality of applicants, so we believe that the size of the bias is likely to be small.

[2] To avoid a low response rate the survey deliberately excludes questions on wage offers and recruitment costs incurred. The data set covers a period of 8 years starting in 1991, which was a period of a slack labour market (a recession would follow in 1993 and 1994), and terminating in 1998; a year characterised by a very tight labour market due to 3 years of continuous employment growth.

One of these is then randomly selected (it need not to be the last one) for an in-depth interview. We analyse information from this interview. A hiring activity may involve the filling of multiple *identical* vacancies. For the (randomly selected) hiring activity, the survey provides information on many elements of the recruitment process such as the number of vacancies filled, the number of applicants received, and the recruitment methods used (summary statistics can be found in the Data Appendix). Moreover, background information on both firm and vacancy characteristics (such as the educational level required, whether working experience was required, the presence of maximum age limits, whether it concerned a part-time position, and whether it concerned a permanent contract) are also provided.

Firms may use multiple recruitment methods during the hiring procedure (sequentially or simultaneously). In the analysis, we distinguish recruitment activities by the first employed recruitment method, which is predominantly the only recruitment method used. Most firms usually use only one recruitment method: in 82% of the cases (a randomly selected hiring activity) only one recruitment method was used. The percentage of employers using a certain recruitment method for a hiring activity is given in the first column of Table 1.

Table 1 ABOUT HERE

In Table 1, the job four recruitment methods are informal recruitment methods (Rees 1966). The residual category "Other recruitment methods" includes recruitment methods such as internet recruiting. Advertisements are the most frequently used recruitment method, covering almost 30% of all hiring activities, more than 30% of vacancies and almost 70% of all job applications.[3]

Given the hypothesis of sequential search, the theory exposed in the previous section conjectures a proportional relationship between the average number of applicants and the average number of vacancies. Consequently, the average number of applicants per filled vacancy should then not depend on the number of vacancies filled. The average number of applicants per vacancy by recruitment method is shown in Table 2.[4]

Table 2 ABOUT HERE

[3] The percentages relating to vacancies and job applications have been based on hiring activities that use only one recruitment method. The percentage of employers using advertisements was much higher at the beginning of the 1990s and then steadily declined to reach the minimum in 1996 and then rebound to 28% in 1998. The percentage of employers using informal recruitment methods (and the use of open applications in particular) has consistently moved in the opposite direction.

The average number of applicants falls as the number of vacancies filled increases for most recruitment methods, but particularly for advertisements. This preliminary analysis does not support the hypothesis of sequential hiring for most methods, but sequential hiring seems to hold for the informal recruitment methods. The last column in Table 2 shows that firms, on average, receive about nine applicants per vacancy. The variation in the average number of applicants per vacancy across recruitment methods is substantial. Advertisements and head-hunters show a significantly higher number of applicants per vacancy. The use of business relations and school recruitment imply, on average, a particularly low number of applicants per vacancy.

3.2 Multivariate analysis

We now turn to the multivariate analysis where we control for a large number of variables. Because the descriptive analysis indicates that the average number of applicants per vacancy differs substantially between recruitment methods, we will estimate equation (2) for each recruitment method separately.[5] The results are presented in Table 3.

Table 3 ABOUT HERE

The first row in the table contains the estimates of the main parameter of interest, γ. The test of sequential recruitment consists in testing whether this coefficient is statistically smaller than one. The test strongly rejects sequential recruitment when the (first) recruitment method is the public employment office, advertisements, or the head-hunters (professional recruitment agencies). These three methods cover 45% of the vacancies and 78% of the job applications. For the recruitment methods were sequential recruitment is rejected, the coefficient γ is far less than one, and it is the lowest for advertising (0.54).

For the informal recruitment method and school recruitment, the hypothesis of sequential hiring cannot be rejected. In case of internal recruitment and temporary help agencies, sequential search is rejected by our statistical test, but the value of the coefficient is

[4] In about 90% of the cases less than five vacancies were filled, therefore the table is quite representative.

[5] To minimise the potential bias due to the presence of multiple recruitment methods, we include the use of an additional method (10 dummies) and interaction terms between the number of vacancies filled and the additional recruitment methods used. An analysis of vacancies that use merely one recruitment method generates almost identical results, and can be received upon request. It follows that the potential bias arising from our choice to classify recruitment actions on the basis of the first recruitment method used (when firms may use multiple recruitment methods) is of little consequence for our analysis.

close to unity. Even if the coefficient is statistically significantly smaller than one, from an economic point of view, one may still argue that sequential search is a good approximation. Therefore, we are ambiguous about the rejection of the hypothesis of sequential search when internal recruitment and temporary help agencies are used. Summarising, when *informal* recruitment methods are used, sequential recruitment is a good assumption, but for the predominantly used formal recruitment methods (except for the use of temporary help agencies), this is not the case.[6]

Our results square well with the results reported in Van Ours and Ridder (1992) and Van Ours and Ridder (1993) who, using other Dutch data than we do, stress the importance of non-sequential search and the importance of selection times; so the vacancy duration is mainly a selection period. The predominant use of advertising in the Dutch labour market is suggested as one of the explanations for their findings.[7] We have demonstrated that this is indeed the case: firms search non-sequentially when using advertising.

4. Conclusion

In this paper we have analysed firms' recruitment process to test whether firms hire sequentially or non-sequentially. This test is based on the relationship between the number of applicants and the number of recruitment methods. Using a large Dutch data set compiled of filled vacancies, and controlling for many vacancy and firm characteristics, we do not reject the hypothesis of sequential search when firms use informal recruitment methods (and temporary help agencies). However, we reject the null hypothesis of sequential search when firms use advertisements, the public employment office, and head-hunters, which cover almost half of the filled vacancies, and the large majority of the job applications by job seekers.[8] Our results confirm that non-sequential search is an important feature of the Dutch labour market, and a substantial fraction of job applicants is involved in non-sequential recruitment procedures. This may have implications for the modelling of firm search in

[6] We have also tested for non-linearity in the relationship between the average number of applicants and the number of vacancies. To this end, we have included a quadratic term in the number of filled vacancies among the regressors. The coefficient of the quadratic term is never significant for any of the informal recruitment methods (so that the presence of a non-linear relationship can be rejected). Moreover, when the internal recruitment method is used the coefficient of the number of filled vacancies jumps to 0.97 (with a standard error of 0.05), so the hypothesis of sequential search cannot longer be rejected. This strengthens our belief that firms search non-sequentially when they recruit internally. We could not reject the hypothesis of non-linear relationship in the case of the use of temporary help agencies, however. The coefficient of the number of filled vacancies squared is positive and statistically significant. These results can be obtained form the authors upon request.

[7] The long selection time is in line with the large number of applicants making use of advertising.

theoretical search equilibrium models of the labour market, but also for the job matching function (Coles and Smith, 1998). Although this result is consistent with other research conducted in the Netherlands we must be careful in extending our results to other countries. This task is left for the future (when suitable data will be available).

[8] One applicant can apply to more than one vacancy, so strictly speaking, job applications cannot be interpreted as job seekers, but the results can be interpreted to indicate that the large majority of job seekers are involved in a non-sequential selection process.

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Table 1: Frequency Distribution of Hiring Activities, Vacancies and Applications

	Hiring Activity	Hiring Activity	Vacancies	Applications
	(1)	(2)	(3)	(4)
Internal Recruitment	9.37	8.29	7.65	3.11
Via Own Personnel	6.95	6.92	6.50	1.97
Business Relations	6.25	6.97	4.54	1.54
Open Applications	13.67	15.03	18.61	7.68
Advertisements	27.99	29.45	31.93	68.49
Temporary Help Agencies	10.60	10.53	9.92	4.10
Public Employment Office	14.35	12.59	11.47	6.81
School Recruitment	2.94	3.15	2.65	0.95
Headhunters	2.70	3.00	2.07	3.16
Other Recruitment Method	5.18	4.08	4.65	2.20
Total	100	100	100	100
Number of Observations	39647	32545	70728	450857

Note: the first column has been based on all observations. The last three columns have been based on hiring activities that use only one recruitment method.

Table 2: The Average Number of Applicants per Vacancy by Recruitment Method

	Number of Vacancies Filled				Mean Applicant
Recruitment Method	1	2	3	4	per Vacancy
Internal Recruitment	6.77	4.98	4.14	3.37	6.10
Via Own Personnel	3.21	2.88	2.82	2.17	3.07
Business Relations	2.75	2.44	1.94	1.82	2.66
Open Applications	3.05	2.93	3.52	3.18	3.07
Advertisements	26.99	14.89	10.89	10.28	22.45
Temporary Help Agencies	4.66	3.99	3.13	2.61	4.29
Public Employment Office	7.25	4.52	4.07	3.77	6.23
School Recruitment	2.68	2.45	3.11	3.51	2.69
Headhunters	12.87	8.71	5.31	5.29	11.71
Other Recruitment Method	4.29	3.81	3.82	2.27	4.12
Mean Applicant per Vacancy	11.08	7.07	5.62	5.07	9.01
Number of Observations	24055	7167	2846	1516	39647

Table 3: Regression of the Number of Applicants by Recruitment Method. Heteroskedasiticity Corrected Standard Errors (*: significant at 5%).

Dependent Variable: Log Number of Applicants.

	Internal Recruitment		Via Own Personnel		Via Business Relations		Open Applications		Advertisements	
	Coeff.	Std. Err.	Coeff.	Std. Err.	Coeff.	Std. Err.	Coeff.	Std. Err.	Coeff.	Std. Err.
Log Number of Filled Vacancies	0.92	0.02*	0.99	0.02*	1.01	0.03*	1.00	0.02*	0.54	0.02*
Educational Requirements										
University	0.07	0.11	0.18	0.12	0.30	0.10*	0.21	0.10*	0.62	0.08*
Upper Vocational	0.14	0.07*	0.14	0.07*	0.23	0.06*	0.16	0.06*	0.55	0.05*
Upper Secondary General	0.18	0.09*	0.06	0.08	0.02	0.08	0.11	0.07	0.53	0.07*
Secondary Vocational	0.17	0.06*	0.11	0.05*	0.06	0.05	0.05	0.04	0.35	0.04*
Secondary General	0.01	0.08	0.03	0.06	0.11	0.07	0.19	0.05*	0.25	0.05*
Primary Vocational	0.06	0.06	0.01	0.04	0.04	0.04	0.04	0.03	0.01	0.04
Vacancy Characteristics										
Part Time	-0.08	0.03*	0.01	0.03	0.01	0.04	0.00	0.03	0.01	0.03
Permanent	0.16	0.03*	0.07	0.03*	0.10	0.03*	0.01	0.02	0.20	0.03*
Experience Required	0.01	0.04	0.07	0.03*	0.05	0.03	0.02	0.02	0.06	0.03*
Age Limits	0.25	0.05*	0.19	0.04*	0.15	0.05*	0.17	0.03*	0.19	0.03*
Log Number of Employees	0.11	0.01*	0.07	0.01*	0.07	0.01*	0.08	0.01*	0.08	0.01*
Business Cycle										
Log Vacancies/Employment (Regional)	-0.07	0.05	-0.09	0.05	0.05	0.05	0.02	0.04	-0.08	0.04*
Log Unemployment Rate (Regional)	-0.02	0.13	-0.15	0.12	0.06	0.13	0.13	0.10	0.16	0.11
Yearly Dummies (7)	Yes		Yes		Yes		Yes		Yes	
Occupational Dummies (8)	Yes		Yes		Yes		Yes		Yes	
Industry Dummies (8)	Yes		Yes		Yes		Yes		Yes	
Additional Recruitment Method (10 dummies)	Yes		Yes		Yes		Yes		Yes	
Number of Vacancies * Additional Method (10 variables)	Yes		Yes		Yes		Yes		Yes	
Constant	-0.08	0.27	0.12	0.25	-0.245	0.2776	-0.28	0.20	0.84	0.22*
Number of Observations	3715		2755		2476		5418		11096	
Ftest	95.41		99.95		52.75		197.74		74.01	
R^2	0.56		0.6206		0.44		0.6101		0.25	

Table 3 Continued

Dependent Variable: Log Number of Applicants.

	Temporary Help Agencies		Public Employment Service		School Recruitment		Headhunters		Other Recruitment Methods	
	Coeff.	Std. Err.	Coeff.	Std. Err.	Coeff.	Std. Err.	Coeff.	Std. Err.	Coeff.	Std. Err.
Log Number of Filled Vacancies	0.92	0.02*	0.78	0.02*	0.96	0.04*	0.70	0.07*	0.80	0.09*
Educational Requirements										
University	0.45	0.21*	0.07	0.14	0.02	0.22	0.08	0.26	0.23	0.13
Upper Vocational	0.50	0.07*	0.05	0.07	0.03	0.14	0.17	0.22	0.23	0.09*
Upper Secondary General	0.38	0.08*	0.19	0.08*	0.34	0.24	0.34	0.29	0.09	0.14
Secondary Vocational	0.30	0.05*	0.17	0.05*	0.04	0.12	0.28	0.22	0.05	0.07
Secondary General	0.16	0.06*	0.10	0.05	-0.07	0.14	0.00	0.27	0.02	0.09
Primary Vocational	0.09	0.04*	0.04	0.04	0.04	0.11	0.02	0.22	-0.02	0.06
Vacancy Characteristics										
Part Time	-0.04	0.05	-0.06	0.03*	-0.11	0.07	0.17	0.12	-0.01	0.05
Permanent	0.16	0.03*	0.24	0.03*	0.04	0.05	0.50	0.11*	0.20	0.04*
Experience Required	0.04	0.03	0.05	0.03*	-0.01	0.05	-0.03	0.12	0.01	0.04
Age Limits	0.21	0.03*	0.18	0.03*	0.20	0.06*	0.60	0.10*	0.35	0.07*
Log Number of Employees	0.02	0.01	0.04	0.01*	0.06	0.02*	0.10	0.03*	0.07	0.01*
Business Cycle										
Log Vacancies/Employment (Regional)	0.01	0.05	0.05	0.04	-0.10	0.07	-0.17	0.13	-0.13	0.08
Log Unemployment Rate (Regional)	-0.02	0.12	0.25	0.12*	-0.22	0.19	0.05	0.32	-0.31	0.19
Yearly Dummies (7)	Yes		Yes		Yes		Yes		Yes	
Occupational Dummies (8)	Yes		Yes		Yes		Yes		Yes	
Industry Dummies (8)	Yes		Yes		Yes		Yes		Yes	
Additional Recruitment Method (10 dummies)	Yes		Yes		Yes		Yes		Yes	
Number of Vacancies * Additional Method (10 variables)	Yes		Yes		Yes		Yes		Yes	
Constant	0.03	0.25	0.01	0.24	0.22	0.42	0.11	0.68	0.83	0.40
Number of Observations	4201		5690		1165		1071		2060	
Ftest	64.36		66.66		23.05		5.07		53.50	
R^2	0.45		0.37		0.58		0.2233		0.49	

Note: Reference Group of the Variables is in Parentheses: Educational Requirements (Primary General), Part Time (Full Time), Permanent (Temporary), Experience Required (No Experience Required), Age Limits (No Age Limits).

Appendix 1: Summary Statistics

Table A1: Summary Statistics of the Variables Used in the Analysis

Variable	Mean	Std. Dev.	Min	Max
Log Number of Applicants	1.61	1.37	0.00	6.90
Log Number of Filled Vacancies	0.48	0.73	0.00	5.97
Educational Requirements				
University	0.03	0.16	0.00	1.00
Upper Vocational	0.18	0.39	0.00	1.00
Upper Secondary General	0.05	0.21	0.00	1.00
Secondary Vocational	0.28	0.45	0.00	1.00
Secondary Genearal	0.08	0.27	0.00	1.00
Primary Vocational	0.27	0.44	0.00	1.00
Primary General	0.11	0.32	0.00	1.00
Vacancy and Firm Characteristics				
Part Time	0.45	0.49	0.00	1.00
Permanent	0.76	0.43	0.00	1.00
Experience Required	0.64	0.48	0.00	1.00
Age Limits	0.19	0.40	0.00	1.00
log Number of Employees	3.89	1.51	0.69	9.15
Business Cycle				
Log Vacancies/Employment (Regional)	-0.13	0.48	-1.23	0.99
Log Unemployment Rate (Regional)	1.94	0.20	1.36	2.48
1991	0.09	0.28	0.00	1.00
1992	0.17	0.38	0.00	1.00
1993	0.15	0.36	0.00	1.00
1994	0.14	0.34	0.00	1.00
1995	0.13	0.33	0.00	1.00
1996	0.09	0.29	0.00	1.00
1997	0.14	0.35	0.00	1.00
1998	0.09	0.29	0.00	1.00
Occupation				
Scientific Personnel	0.10	0.30	0.00	1.00
Consultants	0.09	0.29	0.00	1.00
Managers	0.03	0.17	0.00	1.00
Adminstrative Personnel	0.19	0.39	0.00	1.00
Commercial Personnel	0.11	0.31	0.00	1.00
Service Personnel	0.12	0.32	0.00	1.00
Agricultural Workers	0.02	0.14	0.00	1.00
Supervisory and Production Personnel	0.03	0.17	0.00	1.00
Craftsmen	0.11	0.32	0.00	1.00
Industry				
Agriculture ISBN 1	0.03	0.16	0.00	1.00
Mining ISBN 2	0.09	0.29	0.00	1.00
Manufacturing ISBN 3	0.11	0.31	0.00	1.00
Utilities ISBN 4	0.00	0.06	0.00	1.00
Construction ISBN 5	0.13	0.34	0.00	1.00
Trade and Horeca ISBN 6	0.20	0.40	0.00	1.00
Transport and Communications ISBN 7	0.07	0.25	0.00	1.00
Financial and Business Services ISBN 8	0.11	0.31	0.00	1.00
Personal Services ISBN 9	0.25	0.43	0.00	1.00

Number of Observations 39647